

*LUN Selection For File System Extension*

As discussed above, if a host 12 file system utilization exceeds a pre-defined threshold, its respective agent transmits a request to the SAN manager for file system extension. The agent  
 5 determines the necessity of transmitting such a request by periodically checking host file system utilization, e.g., at a pre-set interval determined by the operator or otherwise. Alternatively, or in addition, it can monitor requests made by the host to its file system and/or monitor the LUNs assigned to the host as part of that file system.

10 Upon receipt of an extension request from an agent, the SAN manager 20 -- and, particularly, policy engine 38A (FIGURES 7A and 7B) -- determines if the host is eligible for file system extension and, if so, whether any of the storage devices (LUNs) accessible to it (and available for assignment) meet the extension criterion for that host. If affirmative on both counts, the manager  
 20 assigns the requisite LUNs to the host in the manner described above.

15 More particularly, in the illustrated embodiment, when the file system monitor 80 (FIGURE 17) detects that a the file utilization of a host has exceeded a pre-defined threshold, for example, via receiving a message from the host's respective agent, an event is sent to the SANStorAuto 78. The policy engine 38a receives this event and determines if the file system can and/or should be  
 20 extended, or if only notification is required. If the file system should be extended, then the policy engine determines what LUN to use and requests that the LUN be assigned to by the SANLunMgr 72. Once the LUN is assigned, a File System Extension service (SANAgenFSExtend) 84 is called to perform the extension by utilizing the host local operating

system to extend the file system onto the newly assigned LUN. As used herein, a file system is that aspect of the host operating system or otherwise that manages or otherwise effects access by the host to files and other information on the assigned storage devices (LUNs) in the conventional manner.

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In the illustrated embodiment, both the host eligibility and extension criteria are set by the operator/administrator on a host-by-host basis, or based on a hierarchical host group structure, as discussed below, though they can be set by default (e.g., based on characteristics of the host) or otherwise. For example, using the GUI interface 98, the operator/administrator can define

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certain hosts as ineligible for file system extension, in which case overutilization by those will have the conventional consequences (e.g., file system warnings and/or errors). Likewise, the operator/administrator can define other hosts as eligible for extension and, more particularly, can define the minimum (lower bound) and maximum (upper bound) available storage capacity of any storage devices assigned the host for that purpose.

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Upon receipt of a file extension request on behalf of an eligible host, the SAN manager selects from among the storage devices accessible to that host based on that minimum and maximum as follows. Referring to the flow chart 152 of FIGURE 27, in step 154, the SAN manager identifies individual storage devices (LUNs), accessible to the host and otherwise available for assignment

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to it (e.g., in the manner described above), whose available storage falls within the range defined by the minimum and maximum. In the case of a host that utilizes a RAID file system with striping, the SAN manager identifies such storage devices where the range of available storage

falls between the minimum divided by (s) and maximum divided by (s), where (s) is the number of stripes specified for that file system.

In step 156, the manager selects, from among the identified storage devices (LUNs), the storage device that has a maximum storage capacity, and assigns this storage device to the requesting host, for example, in a manner described above in the section entitled "Lun Management." Further, in some embodiments, the manager can make this selection and assignment from among storage devices of specific type or characteristic (e.g., as defined for the host by the operator/administrator or otherwise).

In the absence of any storage device with a storage size in a range between the lower and the upper capacities (both, divided by (s), in the case of a striped file system), in step 158, the manager selects a pair or other combination of accessible and available storage devices whose combined storage capacity equals or exceeds the minimum (divided by (s), in the case of a striped file system) for the host in question, but does not exceed the maximum (divided by (s), in the case of a striped file system) for that host. In one embodiment, the manager begins this selection process with an accessible/available storage device having the largest storage capacity. The manager continues by selecting additional storage devices, for example, in a descending order by storage size, until the combined storage capacity of the selected storage devices equals or exceeds the minimum storage capacity and does not exceed the maximum (again, where both the minimum and maximum are divided by (s), in the case of a striped file system). If a suitable combination of two or more storage devices is found, in step 160, the manager assigns the selected storage devices to the requesting host.